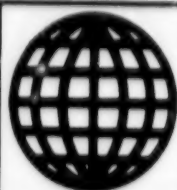


JPRS-UEE-89-005  
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# ***JPRS Report***

# **Science & Technology**

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***USSR: Electronics &  
Electrical Engineering***

# Science & Technology

## USSR: Electronics and Electrical Engineering

JPRS-UEE-89-005

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15 June 1989

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UDC 621.396

**Synthesis of Multiphase Composite Signals**

18600047b Kiev IZVESTIYA VYSSHIKH

UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA

in Russian Vol 31 No 8, Aug 88 (manuscript received,  
after revision, 13 Jul 87) pp 56-58

[Article by V. M. Koshevoy]

[Abstract] Synthesis of discretely encoded multiphase composite signals ensuring sought properties of the signal-reference mutual indeterminacy function in the plane of indeterminacy is considered, signals and filters forming comb structures being selected for the basic

sequence and the external reference sequence respectively. A multiphase sequence is accordingly synthesized which has an indeterminacy function minimally deviating from a comb form with a given orientation and which thus determines the law of variation of complex amplitudes for the signal sequence, whereupon an analogous law of variation of complex amplitudes is selected for the external reference sequence. This method was used for synthesis of an optimum multiphase composite signal with 20x20 positions and with phase modulation optimally encoded for maximum size of the region containing side lobes maximally suppressed by optimal weighting of both sequences. The topographical portrait of its indeterminacy function contains peaks forming where teeth of the two signal and reference combs intersect. Figures 3; references 7: 5 Russian, 2 Western (1 in Russian translation).

UDC 621.397.424.2

**Suppression of Space-Frequency Beats in Small Single-Tube Color Television Cameras**

18600001b Moscow *TEKHNICA KINO I*

*TELEVIDENIYA* in Russian No 8, Aug 88 pp 16-18

[Article by A. G. Vaniyev, V. N. Bezrukov, and S. V. Novakovskiy]

[Abstract] Use of birefringent transparent optics is considered to be the best method of suppressing space-

frequency beats in small single-tube color television cameras, in preference to insertion of low-space-frequency filters requiring a longer space behind the objective and to insertion of auxiliary optics degrading the sensitivity of the camera. An experimental prototype of such a camera without filters or auxiliary optics was built and tested. Quartz or feldspar are most suitable and most readily available materials for the optical elements, Zn-Cd-Te or Se-As-Te layers being most effective as photosensitive coating, especially with a speed increasing additive. Figures 2; references 11: 1 Russian, 10 Western (1 in Russian translation).



UDC 550.388

**Propagation of Internal Gravity Waves Through Atmospheric Waveguide Excited by Turbulent Vortices**

18600034a Gorkiy IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 7, Jul 88 (manuscript received 3 Nov 86) pp 771-777

[Article by I. N. Drobyazko and V. N. Krasilnikov, Leningrad State University]

[Abstract] A model of internal gravity waves is proposed for correlating experimental and theoretical data on anomalous perturbations in the ionosphere. According to this model, such waves are generated in and propagate through a stationary isothermal atmospheric waveguide which forms in a uniform gravitational field as a horizontal layer of infinite length and width but finite thickness upon excitation by the circular cylindrical vortex. This layer of a non-viscous gas with a characteristic speed of sound has a fixed lower boundary and is bounded from above by a half-space filled with a viscous gas having a constant kinematic viscosity and flowing horizontally at a certain velocity, its temperature and therefore also its characteristic speed of sound being higher than those of the waveguide gas. The acoustic field in the waveguide is, with the aid of the residue theorem, represented as a series of normal waves and its frequency characteristics are then calculated with attenuation of sound also taken into account. The results of theoretical calculations based on this model approach the results of measurements when the fields of several atmospheric vortices are additively combined. Figures 5; references 5: Russian.

UDC 533.951

**Characteristics of Diffraction of Surface Waves by Longitudinal Density Jump in Cylindrical Plasma Waveguide**

18600034d Gorkiy IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 7, Jul 88 (manuscript received 3 Jul 86, after completion 24 Aug 87) pp 855-861

[Article by G. I. Zaginaylov and I. B. Shcherbinina, Kharkov State University]

[Abstract] Solution of the diffraction problem for singularities on the basis of the Wiener-Hopf method is proposed, this method yielding the diffraction field in the form of an infinite series with the infinite series with the infinite number of coefficients satisfying an infinite system of algebraic equations. The method is applied to diffraction of surface electromagnetic waves by a longitudinal density jump and consequent jump of dielectric permittivity in a cylindrical plasma waveguide. All space is subdivided here into three regions: interior of the cylinder before the jump, interior of the cylinder behind

the jump, exterior of the cylinder. The solution appears as a superposition of the scattered field on the incident one. Both reflection and transmission coefficients at the jump and also the far-field radiation pattern are calculated with the aid of inverse Fourier transformation. As special cases admitting significant simplifications are surface waves much longer than the field penetration depth in the plasma waveguide with a radius much smaller than the field penetration depth. The authors thank A.N. Kondratenko for interest and helpful discussions. Figures 2; references 19: 13 Russian, 6 Western (1 in Russian translation).

UDC 621.372.822.001

**Variant of Generalized Separation-of-Variables Method for Problem of Scattering by Ideally Conducting Cylinder with corrugated Cross-Section**

18600034c Gorkiy IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 7, Jul 88 (manuscript received Vol 31 No 7, Jul 88 (manuscript received 21 Aug 86) pp 834-838

[Article by V. M. Temnov and M. V. Vardanashvili, Moscow Institute of Electronics Engineering]

[Abstract] A variant of the generalized separation-of-variables method is proposed for solving the problem of a highly deformed scatterer, its gist being introduction of local systems of coordinates with origins at the singular points corresponding to series expansion of the scattered field into radially diverging waves. This not rigorously analytical but numerically effective variant is demonstrated on scattering of an obliquely incident E-polarized plane wave by an ideally conducting and periodically smoothly corrugated cylinder of finite length, the origins of local cylindrical systems of coordinates being placed at the centers of its lobes. The algorithm of the numerical experiment performed for solving the problem is required to converge simultaneously with respect to both boundary condition of a zero axial component of the electric field at the cylinder surface and conservation of energy in terms of a zero integral of the Poynting vector over a closed surface around the scatterer, the magnitude of deviation from these criteria depending on the order of approximation and on the degree of scatterer deformation. Such a numerical experiment was performed on a YeS-1022 computer for cylinders with various numbers of corrugation lobes, using not more than 140 collocation points. Figures 3; references 10: 4 Russian, 6 Western (1 in Russian translation).

UDC 551.510.535

**Multipath Ionograms and Nonhomogeneous Ionosphere Structure**

18600034f Gorkiy IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 7, Jul 88 (manuscript received 2 Mar 87) pp 869-874

[Article by I. I. Varshavskiy and A. D. Kalikhman, Siberian Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Siberian Department, USSR Academy of Sciences]

[Abstract] The nonhomogeneous ionosphere structure is as analyzed on the basis of multipath ionograms synthesized for this purpose, such ionograms with an ambiguous frequency dependence of the group path revealing artificial as well as natural perturbations in the ionosphere. Return trajectories from reflecting inhomogeneities are calculated, inherent segregation of these trajectories into families facilitation of synthesized ionograms with results of physical measurements after shape, size, and location of fictitious inhomogeneities have been selected so that the traces on the ionograms will resemble real ones. Four such ionograms containing falciform singularities as well as complementary traces with frequencies below the critical one for the F2 layer and traces not associated with the location of a high-frequency one are shown which cover almost all situations appearing on naturally recorded ionograms. Figures 4; references 6: 3 Russian, 3 Western.

UDC 525.7

**Spatial Structure of Diffraction Image Formed in Turbulent Atmosphere Along Path with Reflection**  
18600034e Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 7, Jul 88 (manuscript received  
10 Feb 87) pp 867-869

[Article by M. L. Belov and V. M. Orlov, All-Union Scientific Research Institute of Marine Fishing Economy and Oceanography]

[Abstract] The effect of atmospheric turbulence on the dimension of a diffraction image formed along the path with a randomly uneven reflecting target surface and projected by a lens onto the radar screen is analyzed, assuming that such a target surface consists of locally plane elementary Lambert surfaces. The space distribution of radiance in the image plane of the receiver lens is calculated in the approximation of elementary Lambert surfaces with a dimension much larger than the radiation wavelength but much smaller than the characteristic dimension of the randomly uneven surface, than a receiver resolution element, and that the source brightening spot, assuming also that incident and reflected waves travel along different surface inhomogeneities. The results indicate that random surface unevenness can appreciably enlarge the diffraction image in a homogeneous atmosphere as well as in a turbulent one with fluctuations of the dielectric permittivity. Figures 2; references 3: Russian.

UDC 550.510.535

**Response of Ionospheric F-Region to Sequences of Shocks in April 1984 After Gazli Earthquake**  
18600034g Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 7, Jul 88 pp 874-878

[Article by M. N. Fatkullin, T. V. Gayvoronskaya, T. I. Zelenova, and S. S. Khusamiddinov, Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, USSR Academy of Sciences]

[Abstract] The ionospheric F-region was sounded after sequences of shocks on 21, 22, 13, 15, 16 April 1984

following the Gazli earthquake, of particular concern being fluctuations of the ionosphere parameters apparently associated with infrasound waves generated at the earth-air interface by Rayleigh waves and propagating almost vertically into the atmosphere. The results indicate a decrease of the effective heights  $h_r'$  and  $h_m'$  at certain frequencies within the F<sub>0</sub>F2 MHz range, caused either by dropping of the layers or by changes in the lower part of the F-region after or immediately before an underground shock and preceded by a short transient increase of these effective heights. The results also indicate anomalous kinetics of  $h_r'$  and  $h_m'$  at frequencies within the 4.0-5.0 MHz range. Two almost identical shocks on 26 April at 10:42 and 12:14 local time occurred, unlike the others, during a strong magnetospheric storm which had begun on 25 April. A spectral analysis of the  $h_r'$ ,  $h_m'$ , and F<sub>0</sub>F2 time series reveals that  $h_m'$  was most subject to wavelike fluctuations. The authors thank Ye.V. Nemov for performing computer calculations. Figures 4; references 2: Russian.

UDC 621.371.246

**Analysis of Signal Level Fluctuations Near Atmospheric Absorption Line Taking into Account Directivity of Antenna Systems**  
18600034h Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 7, Jul 88 pp 878-880

[Article by A. S. Bryukhovetskiy, I. M. Fuks, and S. I. Shirmanova]

[Abstract] The effect of directivity of both transmitter and receiver antennas in the analysis of amplitude fluctuations of submillimetric-wave signals propagating through the atmospheric ground layer is evaluated, assuming a plane monochromatic signal wave and antennas with a Gaussian irradiance distribution. The chi-square distribution, calculated with the three structural constants of the transmitter-receiver antenna system expressed in terms of the two structural constants of temperature and humidity fluctuation, reveals a strong dependence on measured signal level fluctuations on the directivity of both antennas. Figures 5; tables 1; references 7: 6 Russian, 1 Western.

UDC 621.391.821:550.388.2

**Formation of Fluctuation Component in ELF-VLF Atmospheric Radio Interference Field**  
18600032a Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 6, Jun 88 (manuscript received  
18 Aug 86) pp 652-659

[Article by V. V. Kabanov, Northeastern Comprehensive Scientific Research Institute, Far-Eastern Science Center, USSR Academy of Sciences]

[Abstract] The fluctuation component of radio interference generated by lightning discharges is evaluated, the theoretical analysis being simplified by approximation

of the real Poisson-Poisson atmospheric interference flux with a simple Poisson flux and by wideband idealization of the real pulse characteristic. Different methods of calculation are used for ELF and VLF fluctuation components of the interference field. The results of numerical estimates are compared with experimental data. They indicate that a significant fluctuation component forms naturally only at low to intermediate frequencies (50-500 Hz) within the ELF band, its intensity at higher frequencies (500-3000 Hz) is made appreciable by use of filters with sharp cutoffs, and does not form at all at frequencies above 5000 Hz. Figures 3; references 19: 14 Russian, 5 Western (1 in Russian translation).

UDC 621.371.332.1

**Reflection Coefficient at  $E_s$ -Layer Along Moscow-Kazan Route**

18600032c Gorkiy IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 6, Jun 88 (manuscript received 2 Jun 86) pp 669-674

[Article by R. G. Minullin and O. N. Sherstyukov, Kazan State University]

[Abstract] An experimental study of the sporadic  $E_s$ -layer was made spanning the June-August 1979 period and involving measurement of its reflection coefficient along the 700 km long Moscow-Kazan route, this ionospheric layer being known to appreciably influence propagation of radio waves over a wide frequency range. An asymmetric vertical 10 m high dipole antenna was used for reception of signals from the Moscow Radio Broadcasting Station riding on a 15 MHz carrier, this carrier frequency being higher than the maximum usable frequency for both E and F layers along the given route. Sounding was done vertically and obliquely, at several points along the route and especially at the midpoint between the two cities. A theoretical analysis of the data, taking into account nondeflecting absorption by both D and E layers, has yielded a correction factor to the secant-law dependence of the reflection coefficient on the incidence angle. Both the reflection coefficient and the correction factor were found to undergo wide diurnal variation, both depending not only on  $f_oE_s$  ( $f_o$ -plasma frequency) and  $f_bE_s$  ( $f_b$ -shielding background frequency) but also on  $f_oE$ . A statistical analysis of the data has established a correlation between the amplitude of signals reflected by the  $E_s$ -layer during oblique sounding and the frequency parameters of this layer when sounded vertically from the midpoint of the Moscow-Kazan route. The frequencies based on vertical and oblique soundings respectively have, furthermore, found to be related through an M-factor equal to the ratio of maximum possible frequency for recordable reflection to critical frequency for vertical sounding. The results based on experimental data are compared with results of theoretical calculations based on models of the  $E_s$ -layer as a thin layer and as a layer with large electron concentration gradient, the experimental data being for this

purpose segregated into day-shift readings (6:00 to 18:00 local time) and night-shift readings (18:00 to 6:00 local time). The comparison reveals that specular reflection of 15 MHz radio waves by the  $E_s$ -layer along the Moscow-Kazan route predominates when the effective reflection coefficient is larger than 0.03, while their scattering predominates when it is smaller than that. The authors thank T. S. Kerbay for interest and for discussion of the results, and L. V. Grishkevich for supplying data from the ionospheric station Gorkiy. Figures 4; references 17: 13 Russian, 4 Western.

UDC 621.391.96:621.391.26

**Synthesis and Analysis of Algorithm for Detection of Distributed Sources in Presence of Distributed Background Interference**

18600040d Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 7, Jul 88 (manuscript received 23 Jul 86) pp 1430-1434

[Article by L. G. Dorosinskiy, Ye. A. Rivelis and A. G. Chirkov]

[Abstract] An optimum algorithm is synthesized for detection, by a discrete antenna array, of wideband signals from an array of N sources appearing with a structurally similar interference from different locations and with additive noise not correlated in space. Signals as well as interference and noise are assumed to become stationary Gaussian processes within a sufficiently long detection time, the harmonic components of each being statistically independent of those of the other two. The algorithm involves Fourier transformations and then processing a finite set of harmonic components, which includes construction of the optimum weight matrix and inversion of matrices of orders determined by the number of signal and interference sources, for calculation of the likelihood ratio. The detection characteristics are analyzed and evaluated with use of the Van Tries-Chernov limit rather than on the basis of Yu. G. Sosulin's exact relations not readily employable here, the algorithm having been designed for digital processing of the receiver input. The results confirm that with small signal-to-interference ratios detection of lumped targets is more efficient and with large signal-to-interference ratios detection of distributed targets is more efficient. Figures 2; references 5: 4 Russian, 1 Western (in Russian translation).

UDC 621.321.025...

**Method and Some Results of Calculating Statistical Characteristics of Small-Scale Fluctuation of Low-Frequency Radio Waves in Near Region**

18600040e Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 7, Jul 88 (manuscript received 18 Nov 86) pp 1438-1446

[Article by G. I. Khudyakov]

[Abstract] A physiocomathematical model of scattering of medium and long radio waves by small-scale inhomogeneities in the lower ionosphere is described, this model



having been proposed by the author for computer-aided numerical-statistical analysis of resulting wave fluctuations within 100-1500 km from the transmitter. The model is based on the magnetoionic theory, both dielectric permittivity and electrical conductivity at any point within the isotropic lower ionosphere as well as the complex index of refraction being expressed accordingly as functions of the frequency. Expressions for the statistical characteristics of amplitude and phase fluctuations are derived in the approximation of double-jump wave propagation and of earth as an ideal conductor. The scattering function is calculated for an electromagnetic wave from a point source approximating a vertical dipole and an individual inhomogeneity either of a Gaussian form or of a dimension comparable with the length of sounding waves. Both correlation function and second correlation function are derived on the same basis, assuming that the real random distributions of electron concentration and electron-atom collision frequency are independent uniform Gaussian random fields with identical Gaussian correlation functions. Figures 4; references 20: 5 Russian, 15 Western (3 in Russian translation).

UDC 621.396:62-505.72

**Simulation of Optical Communication System With Analog Signals and Frequency-Modulated Subcarriers**

18600047a Kiev IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA  
in Russian Vol 31 No 8, Aug 88 (manuscript received,  
after revision, 15 Jun 87) pp 39-42

[Article by N. A. Matiyasevich]

[Abstract] An optical communication system is considered where analog signals representing photon fluxes ride on subcarriers, the carrier having been amplitude-modulated by a frequency-modulated signal. Two methods of simulating such a system on a computer for estimation of its interference immunity during operation in the photon-count mode are described, the algorithm of each yielding both amplitude and phase of the narrow-band photodetector output signal. The first method involves drawing a random Poisson number which represents the number of photo-electrons appearing during a detection period and selecting random numbers which represent the instants of time of their appearance. The second method involves a Gaussian approximation of a Poisson process after passage through a linear filter, the two quadrature components of the filter output signal being regarded as mutually independent nonstationary Gaussian random processes. For a comparative evaluation of the two methods, they are applied to a system which includes a second-order phase-lock automatic frequency control with a nonideal integrator on the demodulator side. Calculations show that the first method is more universal. Figures 2; references 5: 2 Russian, 3 Western (all in Russian translation).

UDC 621.395.5

**Walsh-Type Digital Detectors of Harmonic Signal Components**

18600047c Kiev IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA  
in Russian Vol 31 No 8, Aug 88 (manuscript received,  
after revision, 18 Aug 87) pp 59-61

[Article by A. V. Brunchenko, M. V. Gonikberg and A. Ye. Sedov]

[Abstract] A digital detector with a matched Walsh functions filter is proposed for detecting the harmonic component of a digital signal mixed with additive quantization noise and random speech interference, after all have passed through a shaper of square pulses so that detection of the harmonic component reduces to determination of the pulse repetition rate. Such a digital filter minimizes errors by responding to a given pulse repetition rate throughout the detection interval rather than to an average pulse repetition rate equal to the detection frequency. The real part and the imaginary part of the filter output signal pass each through a decimator and then a squarer, whereupon the output signals from the two squarers are fed to an adder and their sum from there to a threshold device for a decision about presence or absence of a harmonic component. A 32-channel prototype of such a detector was built with approximately 50 integrated-circuit chips on the basis of CMOS technology and was tested with a clock frequency of 512 kHz, matching in performance the detector built with approximately 100 integrated-circuit chips on the basis of Schottky TTL logic and now operating in the DX-200 electronic telephone exchange. Figures 4; references 4: 2 Russian, 2 Western (both in Russian translation).

UDC 621.774:536.521

**Infrared Radiometers With Light Guides: Survey**

18600048a Moscow PRIBORY I TEKHNIKA  
EKSPERIMENTA in Russian No 2, Mar-Apr 88  
(manuscript received 5 Mar 87) pp 5-24

[Article by Ye. S. Avdoshin, Tula State Pedagogical Institute]

[Abstract] Following a classification of infrared radiometers which use light guides without lens, mask, diaphragm, or tube and a description of the two principal types of radiation detectors they use, namely thermal and photoelectric ones, four groups of such infrared radiometers are surveyed in a format which covers design principles as well as construction and performance of the most interesting ones available on the market. The first group comprises those with optical fibers, some using multistrand fibers but most using flexible ones, either as passive radiation conductors or as active sensing devices. The second group comprises those with solid dielectric rods and the third group comprises those with hollow metal pipes, cylindrical or

conical ones. Any of these radiometers can be improved by addition of a hemispherical reflector with a center hole and thus stabilizing the emissivity of the object surface. The fourth group of infrared radiometers comprises those with reflector and light guide. Figures 18; tables 1; references 127: 58 Russian, 2 Polish, 67 Western (1 in Russian translation).

UDC 621.385.6:629.78

#### **Microwave Instrument Radiometers With Digital Read-Out**

18600048g Moscow *PRIBORY I TEKHNIKA EKSPERIMENTA* in Russian No 2, Mar-Apr 88 (manuscript received 11 Aug 86) pp 103-106

[Article by N. N. Vorskiy, Yu. A. Militkiy, V. M. Shainskiy and V. S. Etkin, Institute of Space Research, USSR Academy of Sciences, Moscow]

[Abstract] Two modulation radiometers for 6 cm and 18 cm microwave bands respectively have been designed with division of signals, which ensures suppression of weak multiplicative interference without use of a noise generator in the input stage. A microwave modulator-switch controlled by a reference-voltage generator feeds alternately signals from the receiver antenna and from a "cold" and "hot" load pair to the input of a two-stage microwave amplifier. The amplifier output signal is fed through a decoupling diode and then a filter-detector to a low-frequency amplifier. Its output feeds two synchronous detectors in parallel, one sending a reference-contrast signal and one sending a measured-contrast signal to an analog-to-digital converter with two identical push-pull integrators which divides the measured signal by the reference signal, the quotient then being converted into a proportional time interval and two counters giving a digital read-out. The reference-voltage generator sends not only two pulse signals to the modulator-switch but also two pulse signals to each synchronous detector and two meander signals to the two

push-pull integrators. The temperature difference between "cold" and "hot" loads is stabilized at 100 K by an automatic control system which includes four thermocouples and two proportionally integrating-differentiating filters. These fully transistorized radiometers should be suitable for long-distance sounding. Figures 3; references 4: 2 Russian, 2 Western.

UDC 536.483

#### **Resonance Cells for Millimetric-Wave Radiospectrometer Operating at Temperatures Below 1 K**

18600048h Moscow *PRIBORY I TEKHNIKA EKSPERIMENTA* in Russian No 2, Mar-Apr 88 (manuscript received 6 Jan 87) pp 107-110

[Article by A. A. Vertiy, G. A. Zvyagina, I. V. Ivanchenko, N. A. Popenko, S. I. Tarapov and V. P. Shestopalov, Institute of Radiophysics and Electronics, UkSSR Academy of Science, Kharkov]

[Abstract] A comparative design and performance analysis of resonance cells for a cryogenic millimetric-wave radiospectrometer has indicated that a three-mirror cavity with a total-internal-reflection element is preferable to an open two-mirror cavity, its thermodynamic characteristics being better and less heat being generated in it. Such cells were tested with a radiospectrometer covering the 50-150 GHz frequency range, the experiment involving EPR-spectroscopy of Na HMBA Cr<sup>V</sup> target specimens with various concentrations of paramagnetic impurity at temperatures of 4.2-0.3 K. The apparatus included a <sup>3</sup>He-cryostat, a super-conducting solenoid, two diffraction-radiation generators operating at 75 GHz and 150 GHz respectively, one waveguide transmitting microwave power to the cell, and one waveguide transmitting EPR-signals from the cell. The spectra revealed a splitting and broadening of the nonuniformly broadened spectral line with decreasing temperature. Figures 4; references 7: Russian.



UDC 621.396.98:519.25

**Amalgamation of States in Models of Complex Radio Navigation Systems**

18600047e Kiev IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA  
in Russian Vol 31 No 8, Aug 88 (manuscript received  
22 May 87) pp 90-93

[Article by A. V. Nemov]

[Abstract] Facilitating the analysis of complex radio navigation systems which combine search-and-track instrumentation with geotechnical equipment is considered, models for the analysis of such systems usually representing changes of states in the form of finite, regular, homogeneous, stationary, and ergodic Markov chains. Amalgamation of these models is proposed, and an algorithm is constructed for determining the thus compounded partial errors of estimation which does not require prior determination of the final probability distribution of states in the original system. Amalgamation of models can also be useful for synthesis of complex radio navigation systems, complex models being most expediently amalgamated in stages. Figures 1; references 5: Russian.

UDC 53.085:53.088.2

**Characteristics of Bistatic Lidars**

18600028b Leningrad OPTIKO-MEKHANICHESKAYA  
PROMYSHLENNOST in Russian No 7, Jul 88  
(manuscript received 21 Sep 87) pp 7-10

[Article by R. R. Agishev]

[Abstract] The performance of a bistatic lidar is analyzed for accuracy, the two principal sources of systematic measurement error being incorrect instrument alignment and the background skylight. Each component error is evaluated separately, the relative error due to misalignment as a function of the angular receiver aperture disregarding changes in the viewing angle from a far distance and the relative error due to background radiation as a function of the spectral sky brightness. Inasmuch as the two sources of error are entirely independent of each other, the resultant error is calculated by geometrical addition of the two components. Figures 3; references 9: 7 Russian, 2 Western (1 in Russian translation).

UDC 621.396.67.091.2

**Fluctuations of Power Gain in Antennas on Spacecraft**

18600040b Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 33 No 7, Jul 88  
(manuscript received 20 Jul 86) pp 1409-1414

[Article by I. T. Bubukin]

[Abstract] The performance of antennas mounted on spacecraft is analyzed, taking into account the change in the statistical characteristics of a signal wave as the latter passes from the troposphere into outer space. Fluctuations of the power gain in such an antenna are calculated

in terms of dispersion relative to mean value, considering that the power of an antenna output signal is proportional to the power gain and fluctuations of the antenna temperature results from fluctuations of the directive gain. As a wave propagates through distances  $H$  and  $L$  denoting the height of the earth's atmosphere and the distance in outer space respectively, the dispersion of the directive gain is known to increase owing to transition from phase fluctuations caused by fluctuations of the refractive index of the troposphere to amplitude fluctuations caused by focusing effects in outer space. The relative dispersion of the power gain is calculated for a small antenna as a function of the  $L/H$  ratio of sighting angles from 0 to 85 deg relative to the nadir line and as a function of the sighting angle for wavelengths of 0.8-10 cm. It increases as the sighting angle is increased and as the wavelength is increased, saturating at an  $L/H$  ratio which is smaller for larger sighting angles and running away at a sighting angle which is smaller for shorter waves. Figures 2; references 17: 14 Russian, 3 Western.

UDC 681.325.5

**Device for Widening Dynamic Range of High-Speed Analog-To-Digital Converters**

18600048d Moscow PRIBORY I TEKHNIKA  
EKSPERIMENTA in Russian No 2, Mar-Apr 88  
(manuscript received 23 Feb 87) pp 74-76

[Article by V. P. Doroshev, Belorussian State University, Minsk]

[Abstract] An instrument amplifier with the transfer ratio discretely controlled by current switching has been designed which widens the dynamic range of analog-to-digital converters built with series 1107 LSI circuit chips for processing aperiodic signals, the overall dynamic range  $D$  of incoming signals being subdivided into  $n$  subranges  $d$  such that  $D$  is equal to  $d^n$ . The amplifier consists of a parallel-connected bank of differential transistor pairs, one for each subrange, including resistors in the emitter circuits which determine the transfer ratio within the respective subrange, all feeding a common load of two parallel-connected differential transistor pairs followed by two voltage divided resistors and all supplied from a common current generator through transistor switches. This configuration satisfies the contradictory requirements of high amplifier stability and response speed, regulation of the transfer ratio within each subrange being effected by the switching of the stable generator output current so that the idle transistor pairs do not influence the performance of the operating one. There are a subrange selector and a subrange decoder, also a delay line which eliminates the dynamic conversion error due to delay of control signals to the subrange selector, a synchronizer, and an operational buffer amplifier between the instrument amplifier and the analog-to-digital converter. With this device an analog-to-digital converter can process signals of 1 mV to 12 V bipolar amplitude at a high speed corresponding to 150 ns response time. Figures 3; references 3: 2 Russian, 1 Western (in Russian translation).

UDC 621.313.334

**Peculiarities of Design and Performance Calculations for Brushless Salient-Pole Selsyns**

18600024b Novocherkassk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY:

ELEKTROMEKHANIKA in Russian No 7, Jul 88  
(manuscript received 8 Oct 87) pp 60-67

[Article by Nodar Vasilyevich Kvachakidze, senior instructor, Georgian Polytechnic Institute, and David Veniaminovich Svecharnik, doctor of technical sciences, professor, Moscow Institute of Railroad Transportation Engineers]

[Abstract] Following derivation of a general analytical expression which describes the distribution of quadrature-axis armature reaction in Iosifyan-Svecharnik BEI brushless salient-pole selsyns, the quadrature-axis magnetizing armature reactance  $x_{aq}$  and the quadrature-axis transient reactance  $x'_s$  are calculated by a precise method which uses the equivalent straight pole width and takes into account peculiar to such a machine consequences of a laminated rotor structure. Numerical results pertaining to several selsyns in this class designed some for 50 Hz frequency and some for 400 Hz frequency are much closer to results of measurements than are those obtained by the conventional method with simplifying approximations, the discrepancy between precisely obtained values and average experimental values hardly exceeding the variance of true values. Figures 2; tables 2; references 5: Russian.

UDC 681.522.001.2

**Comparative Evaluation of Two Schemes for Tracking System With Two Actuators**

18600024c Novocherkassk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY:

ELEKTROMEKHANIKA in Russian No 7, Jul 88  
(manuscript received 8 Oct 87) pp 73-78

[Article by Aleksandr Sergeyevich Tsepkov, candidate of technical sciences, docent, and Svetlana Aleksandrovna Khrizolitova, senior instructor, Moscow Institute of Electrical Engineering]

[Abstract] Two schemes for an electromechanical quick-response tracking system with separate coarse-control actuator and fine-control actuator in parallel are comparatively evaluated by the method of automatic control theory. The first scheme includes one common error sensor for both actuators and thus consists of two loops. The second scheme includes two error sensors, one for each actuator, and thus consists of three loops. A performance analysis of both schemes, including calculation of the logarithmic amplitude-frequency characteristic of each actuator in both schemes, indicates that the second scheme with two separate error sensors is more stable. Its stability depends only on the stability of both actuators,

their stability not being a sufficient condition for stability of the first scheme. Its phase margin at the cutoff frequency is smaller than that of the first scheme and its transient-state characteristics are correspondingly worse, but not sufficiently to cause instability. Figures 5; references 2: Russian.

UDC 62-526

**Computer-Aided Stability Analysis of Reversible Tracking System**

18600037a Leningrad IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY:

PRIBOROSTROYENIYE in Russian  
Vol 31 No 8, Aug 88 (manuscript received  
30 Nov 87) pp 24-30

[Article by A. M. Likhomanov, Plant of Higher Technical Educational Institution, Turbine Production Department, 'Leningrad Metal Works']

[Abstract] Computer-aided stability analysis of reversible tracking system on the basis of Mikhaylov's criterion is demonstrated on such a system built into a copying manipulator. The complete system is broken down into the tracking module proper with the external kinematic chains of driver and driven mechanisms linked to it. The tracking module includes, besides forward and reverse drive controls, also amplifier-corrector sets in both position control and torque control loops. Calculations by the method of matrices are programmed for a computer, which solves the characteristic equation and yields a Mikhaylov hodograph of such a system. Figures 4; references 5: Russian.

UDC 681.586.57

**Angular-Position Sensor with Quadrantal Photodetector**

18600037b Leningrad IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY:

PRIBOROSTROYENIYE in Russian  
Vol 31 No 8, Aug 88 (manuscript received  
18 Mar 87) pp 69-71

[Article by A. A. Aleksandrov, S. A. Novoselov, and M. V. Shakhmatov, Moscow Institute of Engineering Physics]

[Abstract] The performance of angular position sensors with a quadrantal photodetector is analyzed, the two most common configurations for forming in the plane of the photodetector a defocused image of the light source being: either photodetector with the rest of receiver optics mounted directly on the object or only mirror mounted on the object and all remaining optics mounted on the remote platform which carries the light source. The required width of the discrimination band determines the magnitude of defocusing. The error of angle measurements in two independent directions depends

principally on the radial intensity profile or the brightening light beam and on the diameter of the latter relative to that of the entrance pupil, equal areas under the illuminance curves over the two sensitive photodetector half-planes being the condition for zero signal and photodetector mismatch. Both discrimination and error characteristics calculated for each of the two configurations reveal that the second one, with the sensor error proportional to the maximum null-angle shift on the discrimination characteristic squared, is preferable for narrow-angle optical sensors. Figures 3; references 2: Russian.

UDC (541.136:681.3).001.4

**Models of Chemical Sources of Electric Current in Factographical Search System**

18600038a Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 88 (manuscript received 22 Jul 87) pp 2-5

[Article by G. F. Muchnik, doctor of technical sciences, and V. P. Mikhaylova, candidate of technical sciences, All-Union Scientific Research Institute of Current Sources]

[Abstract] An automated data bank about chemical sources of electric current has been set up for their performance analysis with use of the Poisk ("Search")-1.2 application program package controlled by a YeS-6.1 operating system. It contains technical specifications, nomenclature charts, and reference information. With the aid of this data bank can be calculated not only the discharge characteristic of a current source, the principal item, but also other performance indicators such as mass and reliability for application and selection purposes. The data bank is designed for factographical search, namely numerical analysis and synthesis. The automatic information retrieval system has for this been modified accordingly so that Poisk-1.2 can be used as standard software for computer user in the interactive mode and an interface for computation of supplementary influencing factors, which avoids reorganizations of the data processing with resorting to additional software not included in the Poisk-1.2 and to extraneous routines. Data on chemical sources of current are in the modified data bank presented in the following sequence of models: conceptual scheme—premachine (PRIM) format—primary edited (FPMTR) format—secondary edited (ED10)

format—main data base and sub-bases containing TEXT, TNDX, INVT, DICT files—expandable text-index file—letterheads for printout control—systematic directory. Figures 2.

UDC 621.35.001.2

**Optimization of Certain Parameters Which Determine Performance of Chemical Current Sources**

18600038b Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 88 (manuscript received 24 Sep 86) pp 9-12

[Article by V. Ye. Dmitrenko, doctor of technical sciences, V. V. Berendt, candidate of technical sciences, I. M. Braude, candidate of technical sciences, and T. F. Fedorova, candidate of physical and mathematical sciences, All-Union Scientific Research Institute of Current Sources]

[Abstract] A model of a chemical current source is proposed for optimization of the electrochemical process, namely distribution of the reaction rate and thus the current density over the height of the electrodes. Both electrodes, parallel rectangular plates in vertical position are assumed to have their active mass uniformly spread over high-conductivity metal substrates and to carry each a current lead in the form of a straight busbar, in the standard horizontal configuration with both busbars along the top edges, in a horizontal configuration with one along the top edges of its electrode and one along the bottom edge of its electrode, or in a vertical configuration with both busbars along lateral edges on the same side. The optimum design is defined as that which yields the most nearly uniform vertical current density distribution. The six design parameters are electrical resistivity  $\rho_1$  and  $\rho_2$  of the two electrode materials, thickness and height of the two electrodes, electrical resistivity of the electrolyte between the two electrodes, and a function of the ration of discharge level to theoretical capacity with the dimension of electrical conductivity. They are lumped together into two dimensionless parameters: alpha combining the sum  $\rho_1$  plus  $\rho_2$  with all the others and beta equal to the ratio of  $\rho_1$  to  $\rho_2$ . Most nearly uniform current density distribution is attainable with the busbars along opposite horizontal edges, with large alpha, and with beta equal or close to unity. Figures 5; references 7: 2 Russian, 5 Western.



UDC 681.7.028

**Phase Randomization for Identification of Optoelectronic Instruments**

18600028d Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 7, Jul 88  
(manuscript received 22 Dec 87) pp 17-19

[Article by A. P. Zakharnev]

[Abstract] Phase randomization and histogram compilation for the purpose of determining the transfer function or response characteristic of an optoelectronic instrument are demonstrated analytically, both procedures being applicable to such instruments as a scanning radiometer. Phase randomization eliminates the phase error where the space derivative of the response signal at the instrument output with phase interference at the input serves as estimate of the instrument's pulse response characteristic, this derivative being referred to the luminance "jump" in space during identification of an aperiodic optoelectronic system by the method of steepest descent. Histogram compilation separates a signal from additive noise without requiring phase synchronization, which is required for increasing the signal-to-noise ratio by synchronous compilation of piecewise-monotonic response signals of an aperiodic optoelectronic instrument. Figures 1; references 6: 4 Russian, 2 Western (both in Russian translation).

UDC 621.383.811

**Optimization of Characteristics of Optoelectronic Systems With Channel Plate Amplification of Image Intensity**

18600028e Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 7, Jul 88  
(manuscript received 8 Oct 87) pp 19-20

[Article by G. S. Kravchuk, I. R. Petrova, Yu. V. Sen, A. M. Tyutikov, and Yu. A. Flegontov]

[Abstract] An analytical method of optimizing the contrast-frequency characteristic of an optoelectronic system which consists of a channel plate multiplier and a screen with an electrostatic lens between them has been developed, considering that experimental determination of all influencing factors is very laborious and computer-aided numerical simulation of all pertinent physical processes requires much machine time. The method takes into account that the size of the electron scattering spot, which determines the image quality, depends on the channel diameter and on the electric field intensity in the gap between plate and screen. The image spot can be minimized by decreasing the channel diameter, with both the gap width and the plate voltage remaining fixed, but then the focal power of the electrostatic lens will also decrease so that slow electrons and fast electrons will be focused in two different planes. The optimum electric field intensity in the gap, for minimum size of the scattering spot, must be calculated for each channel size

and any given gap width. As performance standard is selected a 30 pct contrast level and the corresponding space frequency serves as criterion for optimization of the contrast-frequency characteristic. Calculations made for a microchannel plate with channels 0.010 mm in diameter, a plate voltage of 800 V, and a 0.5 mm or 1.0 mm wide gap between plate and screen have yielded a dependence of the image resolution on the electric field intensity in the gap indicating that the maximum resolution in terms of line pairs per millimeter corresponds to some intermediate electric field intensity (5-6 kV/mm), which agrees closely with experimental data, and contrast-frequency characteristics indicating that higher space frequencies yield higher contrast levels. Figures 2; references 12: 10 Russian, 2 Western.

UDC 681.7.013

**Instrument for Measuring Contrast Transmission Coefficient of Optoelectronic Image Converters**

18600028f Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 7, Jul 88  
(manuscript received 22 May 87) pp 26-27

[Article by T. M. Aysin, Yu. A. Lushin, S. A. Muravleva, A. V. Podobryanskiy, and F. P. Khlebnikov]

[Abstract] An instrument with an "inverted" optical scheme which measures the contrast transmission coefficient for quality control and performance analysis of optoelectronic image converters is described, such a scheme proposed by N. S. Capani being the only one which makes automation of measurements involving persistent-image devices possible. A spherical luminaire contains inside a light source at a 2850 K color temperature, a stationary slotted diaphragm as test object illuminated by this source, and a microobjective which projects its image onto the photocathode of the tested converter. The instrument includes also a mechanically driven movable image analyzer, another microobjective, a disk carrying an array of rectangular gratings configured into a discrete Archimedean spiral for space filtration of the diaphragm image, a light-emitting diode, a photodiode, a photomultiplier, a stabilized voltage source, a stabilized current source, electronic circuitry for processing electric signals, and a digital indicator. The filter configuration and a synchronous detector ensure that the results of signal processing are not affected by changes in light source brightness, converter gain, or photomultiplier sensitivity and that the interference immunity of the instrument remains high at low illumination levels. The performance of this instrument compares with that of the British "EFROS-200" and that of the Dutch "Odeta". Figures 1; tables 1; references 5: 4 Russian, 1 Western (in Russian translation).

UDC 535.855.4

**Effect of Interferometer Error on Instrument Function of Fourier Spectroradiometer**

18600037c Leningrad IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY:  
PRIBOROSTROYENIYE in Russian  
Vol 31 No 8, Aug 88 (manuscript received  
29 Oct 87) pp 71-76

[Article by N. V. Demidov and V. V. Murashov, Leningrad Institute of Precision Mechanics and Optics]

[Abstract] The instrument function of a Fourier spectroradiometer is calculated with the manufacturing imprecision of the interferometer optics taken into account, the two parameters of this function essential for calibration of such an instrument being its amplitude and half-width at various wavelengths within the operating spectrum. Nonparallelism of interfering light rays, the consequence of errors in interferometer optics, is included in calculation of interferograms by Yu. V. Kolomiytsov's method with the light source assumed to be uniformly bright over its entire surface and the interfering rays assumed to have a common center in the plane of the exit pupil at one side of a square hole. Interferograms of monochromatic radiation with a deformed wave along a plane one appearing in the last lens of the optical system are calculated accordingly for a spherical deformed wave and for a cylindrical deformed one, also a wave with local deformations which, in the first approximation, can be regarded as spherical ones bounded by circles. Figures 3; references 3: 1 Russian, 2 Western (both in Russian translation).

UDC 621.317:621.376

**Characteristics of Polytron Operation in Signal Classification Mode**

18600040f Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 7, Jul 88  
(manuscript received 25 Feb 86) pp 1509-1514

[Article by A. I. Stavitskiy, V. I. Stavitskiy, A. A. Fedoseyev and N. E. Gvozdkova]

[Abstract] Operation of a polytron as signal classifier is described, this electron-beam device with a nonlinear performance characteristic electrically controllable within 3-5 pct being used in analog computers. The electron beam passes through the electric field produced by an input voltage across the sweep plates and a control voltage across the function plates, ten pairs of isolated function plates allowing an independent selection of ten voltages a combination of which provides the control action. Three models of this device are compared, a nonlinear analog one and two digital ones: a physical model based on electro-statics and an exponential simulation model. The process of signal classification is treated as a stationary random one. The contrast forming capability of a polytron is evaluated on the basis of an

experiment involving an electric noise signal, the class of its realization being determined by whichever of the two sources A or B has been sampled and the difference within a class depending on the action of multiplicative interference caused by gain variations in the amplifier. The results of an experiment, which included measurement of the load currents in the sweep plates, indicates that a nonlinear analog model does not adequately describe a polytron operating in the signal classification mode with constant control action. Figures 3; references 7: 6 Russian, 1 Western (in Russian translation).

UDC 621.378

**Errors of Current Measurement in High-Current Electron Beam**

18600048b Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 88  
(manuscript received 9 Feb 87) pp 25-26

[Article by N. A. Kondratyev, G. I. Kotlyarevskiy, V. I. Smetanin and Yu. P. Surikov, Scientific Research Institute of Nuclear Physics at Tomsk Polytechnic Institute]

[Abstract] Errors of current measurements in a high-current relativistic electron beam interacting with a gaseous medium are analyzed, measurements with a resistive reverse-current shunt and also with a nonvacuumized Faraday cylinder having been made during interaction in a 1 MeV electron beam and a 4:1 N<sub>2</sub>:O<sub>2</sub> gas mixture in a 60 cm long drift tube and in a 140 cm long one with the shunt or the cylinder mounted radially near the end of each tube and thus respectively 60 cm or 140 cm away from the accelerator anode. The current readings of each instrument as well as their difference or ratio were found to depend not only on the gas pressure but also on the distance from the accelerator anode, the difference between readings taken with the shunt at both locations reaching 30-35 pct at an intermediate gas pressure about 80 torrs and the difference between readings taken with the two instruments at the same location reaching 60-70 pct at a low gas pressure of 10 torrs or at a high pressure of 500 torrs. Figures 2; references 1: Russian.

UDC 621.384.64

**Magnetically Isolated Diode Producing Monoenergetic High-Density Electron Beam in Pulses of Nanosecond Duration**

18600048c Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 2, Mar-Apr 88  
(manuscript received 16 Feb 87) pp 27-29

[Article by P. Ya. Isakov, A. V. Kozhevnikov, V. A. Lukin and V. S. Pak, Scientific Research Institute of Nuclear Physics at Tomsk Polytechnic Institute]

[Abstract] A diode has been designed and built to produce extremely thin monoenergetic high-current electron beams in pulses of nanosecond duration. It was tested in



an experiment with the Tonus accelerator. The drift tube containing both its straight graphite pin cathode 3 mm in diameter and concavoplane graphite disk anode 12 mm in diameter with a center hole 7 mm in diameter was placed coaxially inside a solenoid which produced a uniform magnetic field, the anode in a fixed position and the cathode movable so as to allow varying the interelectrode gap over the 8-15 mm range without disassembly. The magnetic field intensity was varied over the 2-25 kG range. Voltage pulses of 1 MV amplitude and 60 ns width at the half-amplitude level were applied to the

diode and recorded through a standard capacitive voltage divider. The electron current past the hole in the anode was measured with a Faraday cylinder. An evaluation of the experimental performance data with the support of theoretical and numerical design analysis indicates that an optimum configuration of the electrodes will yield an electron beam with characteristics required for certain applications such as a free-electron laser, in this case a beam 7 mm in diameter carrying an electron current of up to 2.2 kA. Figures 3; references 6: 3 Russian, 3 Western (1 in Russian translation).

UDC 535.8:535.124.4

**Automatic Two-Channel Null-Method Radiometer for 3-MM Wave Band**

18600034a Gorkiy IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 7, Jul 88 (manuscript received 17 Jul 86) pp 785-790

[Article by V. I. Nosov, Yu. M. Zabytov, Yu. V. Lebskiy, and A. M. Shtanyuk, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] A two-channel radiometer for the 3-4 mm wave band is described which operates automatically by the null method, this method of reference-signal regulation ensuring a high degree of immunity to gain fluctuations and automatic regulations by feedback control of the reference-signal attenuator not only ensuring higher precision in the case of a constant or slowly varying input signal but being the only possible way in the case of a fast varying one. The attenuator in this instrument is a PIN-modulator, regulation of the length of its open-state time serving as the mechanism for regulating the average reference-signal power with the temperature of the reference-noise generator held constant. Inasmuch as this modulator operates in the switching mode, the nonlinearity of its regulator characteristic becomes irrelevant. The two channels of the instrument are arranged according to the Graham scheme. Each includes a schottky-diode mixer, a synchronous square-law detector, and in the output stage an intermediate-frequency transistor amplifier followed by a low-pass filter, a backward-wave tube serving as heterodyne oscillator common for both channels. A modulator-switch connects the antenna and the PIN-modulator output circuit to the receiver input stage respectively during alternate modulation half-periods. The receiver output signal is fed directly and the detector output signal is fed through two filters to pulse-width modulator, its output current pulses being fed back to the PIN-modulator at a repetition rate equal to twice the modulation frequency with the time interval between them proportional to the input voltage. A disadvantage of using a PIN-modulator with pulse-width-modulation control is that it requires a large bandwidth of the high-frequency stages, 800 MHz for the 34 mm wave band, and a wide dynamic range of the low-frequency stages, which in turn limits the attainable attenuation of anomalous fluctuations. The authors thank A.G. Kislyakov and V.N. Tyukin for formulating the problems and subsequent discussions. Figures 3; table 1; references 6: 5 Russian, 1 Western.

UDC 621.7.068.001

**Dielectric Optical Fibers With Noncircular Core**

18600040a Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 7, Jul 88 (manuscript received 12 Dec 86) pp 1399-1409

[Article by Yu. V. Kolesnichenko and V. V. Shevchenko]

[Abstract] The cutoff frequency and the field distribution of odd and even modes in optical fibers having cores

with noncircular cross-sections are calculated in the "scalar" LP-approximation by V. V. Shevchenko's generalized alpha method of shear formulas. Core cross-sections obtainable by continuous in space deformation of a circle are considered, namely ellipse, dumb-bell, curvilinear equilateral triangle, and curvilinear square, also rectangle and rhombus obtainable by continuous in space deformation of a square. The diameter of the smallest circle embracing the core cross-section of the same diameter and made of an isotropic homogeneous material with a dielectric permittivity  $\epsilon$ , serves as reference, the dielectric permittivity  $\epsilon_0$  of the material around the core inside the sheath assumed to be uniform in all fibers. Frequencies are normalized to  $kR(\epsilon_r - \epsilon_0)^{1/2}$  ( $k$ -wave number,  $R$ -radius of core cross-section). The matrix equation for normalized cutoff frequency and coefficients in the series expansion of the mode field function is solved by numerical integration over subintervals of piecewise continuity, the infinite series having been truncated. The results indicate that deformation of a circular core cross-section into one of different shape and smaller area can lower the cut-off frequency for a mode and that small such deformation produces new modes corresponding to linear combinations, sums and differences, of degenerate LP-modes in a fiber having a core with circular cross-section. The authors thank O. V. Shushpanov for consultations and assistance with numerical calculations. Figures 4; tables 4; references 22: 13 Russian, 9 Western (2 in Russian translation).

UDC 621.786

**Possible Structural Variants of Microwave Beam From Space Solar Power Systems**

18600040h Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 7, Jul 88 (manuscript received 13 Jan 87) pp 1531-1536

[Article by V. A. Vanke, S. K. Lesota and A. V. Rachnikov]

[Abstract] Transmission of solar energy from a space power system by a microwave beam is considered, the most important and to some extent contradictory requirements being high efficiency and low cost combined with sufficiently low background radiation level beyond the receiver antenna and simplicity of technical design respectively. High efficiency, above 90 pct, requires an optimum amplitude-phase distribution over the aperture of the transmitter antenna. A sufficiently dense discrete amplitude distribution approximating a continuous one having already been proposed, it remains necessary to maximize the efficiency of the power transmission channel with such a transmitter antenna and to maximize the mean power density in the receiver antenna as well as the total transmitted power without loss in efficiency. These two problems are tackled analytically, assuming an optimum phase distribution over the aperture of the transmitter antenna, by

solving the system of homogeneous first-order differential equations in Lagrange's function with one undetermined multiplier relating receiver power to transmitter power. The solution involves a surface utilization factor for each antenna, characterizing the degree of power distribution uniformity at each end and thus the radiation pattern of each antenna as well as the structure of the microwave beam which carries energy from one aperture to the other. Numerical calculations indicate that a 10-step discretization of the amplitude distribution over the transmitter antenna aperture does not, under optimum other conditions, lower the efficiency of the power transmission channel by more than 1 pct. Figures 3; tables 1; references 10: 5 Russian, 5 Western.

UDC 621.385.632.2.001

**Amplification of Multifrequency Signals in M-Type Traveling-Wave Tube**

18600040i Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 7, Jul 88* (manuscript received 9 Dec 86) pp 1554-1556

[Article by B. Ye. Zhelezovskiy]

[Abstract] The performance of an M-type traveling-wave tube as amplifier of multifrequency signals is analyzed, taking into account the dispersive characteristics of the slow-wave structures as well as the frequency dependence of both coupling impedance and power loss. The analysis involves theoretical calculations based on the corresponding system of integrodifferential equations and experiment designed according to a rotatable central composite scheme with quadratic polynomials as regression models. The maximum output power at the frequencies of a biharmonic input signal to such an amplifier operating with a thin electron beam in the balanced mode with negligible effects of space charge has been calculated on this basis as a function of normalized coordinates into which the variable parameters have been encoded. Figures 2; references 6: Russian.

UDC 533.951

**Conditions for Excitation of Electromagnetic Waves in Plasma Waveguides With Either Normal or Anomalous Doppler Effect**

18600040j Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 7, Jul 88* (manuscript received 28 Oct 86) pp 1559-1561

[Article by A. N. Kondratenko, V. P. Olefir and Yu. V. Sidorenko]

[Abstract] Excitation of electromagnetic waves by a charged-particle beam in a plasma waveguide with finite plasma radius and magnetic field intensity is analyzed, considering that excitation and amplification of these waves are most efficient when the longitudinal velocity

of the beam and the phase velocity of a wave satisfy the conditions of either normal or anomalous Doppler-effect resonance. The dispersion equation for symmetric volume waves propagating through a homogeneous circular cylindrical plasma waveguide in a uniform longitudinal magnetic field, this equation being a biquadratic one solvable analytically and a complex transcendental one solvable numerically for nonpotential waves. In the former case there are excited two waves, one having a frequency below the plasma cyclotron frequency or the electron cyclotron frequency whichever is lower and one having a frequency above the plasma cyclotron frequency or the electron cyclotron frequency whichever is higher. In the latter case there are excited two complex-conjugate waves whose amplitudes oscillate with exponentially decreasing maxima as the distance from the plasma boundary increases. A special correction term is added to the condition of a normal or anomalous Doppler effect for a relativistic beam, in which case for every magnitude of the plasma radius there is a maximum beam velocity at which the wave guide can be excited under conditions of Cerenkov-effect resonance. Figures 2; references 4: Russian.

UDC 621.372.8.09

**Rectangular Metal Post in Segment of Ridge Waveguide**

18600047d Kiev *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 31 No 8, Aug 88* (manuscript received, after revision. 8 Jul 87) pp 79-80

[Article by F. M. Repa]

[Abstract] The performance of a rectangular capacitive metal post in a segment of a rectangular ridge waveguide is analyzed, as has been the performance of irises in such waveguides, by expansion of the tangential electric field component in accordance with Galerkin's method into a series of its Q waveguide modes multiplied each by the vector engine function of its transverse electric field component. In the case of a structure consisting of such single-ridge (Pi) or double-ridge (H) waveguides, the conditions of continuity of tangential electric and magnetic field components at each of the four joints reduce the problem to a system of 4Q linear algebraic equations for the amplitudes of the Q waveguide modes of the tangential electric field component at each joint. The results of numerical calculations agree closely with experimental data, the differences being not larger than the experimental error, so that they can be used for design purposes. Figures 3; references 4: Russian.

UDC 621.373.12.14:621.375

**Amplifier-Shaper of Pulses With Up to 3 GHz Repetition Rate**

18600048e Moscow *PRIBORY I TEKNIKA*  
*EKSPERIMENTA* in Russian No 2, Mar-Apr 88  
(manuscript received 2 Mar 87) pp 83-85

[Article by V. N. Ilyushenko and B. I. Avdochenko, Tomsk Institute of Automatic Control Systems and Radioelectronics]

[Abstract] A pulse amplifier-limiter with Schottky-gate transistors has been designed and built as a multifunctional hybrid integrated-circuit device consisting of two components, a two-stage amplifier followed by a three-stage shaper. Pulses are shaped both nonlinearly and linearly for shortening their rise time and fall time, which allows a high repetition rate. Nonlinear shaping involves slight unilateral clipping of the sinusoidal input voltage signal in each stage by cutoff of the transistor drain current. Linear shaping is achieved by use of matching circuits and frequency-dependent negative feedback for attainment of the appropriate operating frequency range, utilizing the nonminimum-phase property of stages with negative feedback. The device can shape voltage pulses with 10 ns wide tops flat within 5 pct and with a rise time not exceeding 60 ps, at repetition rates of 1-3 GHz. Figures 1; references 4: Russian.

UDC 621.373.12

**Stabilized Biharmonic Gunn-Diode Oscillator**

18600048f Moscow *PRIBORY I TEKNIKA*  
*EKSPERIMENTA* in Russian No 2, Mar-Apr 88  
(manuscript received 4 Mar 87) pp 96-98

[Article by V. T. Buzykin, V. Ya. Noskov and B. N. Tumanov, Nizhniy Tagil State Pedagogical Institute]

[Abstract] A biharmonic Gunn-diode oscillator for the 3 cm microwave band has been designed with frequency stabilization of the second harmonic by means of an external high-Q resonator cavity. It consists of two parallel waveguides, one for each harmonic, coupled through a coaxial line segment with an AA715Ye Gunn diode mounted at its end inside the second waveguide and with a band-elimination filter mounted at its center between the two waveguides. The entire coaxial line segment serves as resonator cavity for the first harmonic, its part between filter and Gunn diode serves as resonator cavity for the second harmonic, and the filter facilitates independent tuning of the oscillator at each harmonic. An external resonator cavity behind the second waveguide stabilizes the frequency of the second harmonic. This oscillator was tested for power and modulation characteristics, its performance having found to be satisfactory for its use as reference oscillator. Figures 3; tables 1; references 5: Russian.

UDC 621.391.26

**Optimum Decision Rule for Identification of  
Subscribers to Coupled Radioelectronic Systems**

18600040c Moscow *RADIOTEKHNIKA* 1  
*ELEKTRONIKA* in Russian Vol 33 No 7, Jul 88  
(manuscript received 1 Jul 86) pp 1425-1430

[Article by E. A. Ibatullin]

[Abstract] An optimum decision rule is designed for identification of subscribers to coupled radioelectronic systems with unequal ranges of coverage, the two possible situations in the case of two such systems being  $S_1$  when the subscriber to the "primary" system covering only one subscriber is also a subscriber to the "secondary" system, covering a much wider range and  $S_2$  when the subscriber to the "primary" system does not possess information for the "secondary" system serving a subscriber located within its assigned range. Signals from the two subscribers cannot be identified by conventionally estimating the mathematical expectations of

distances in either case. Instead, the decision rule must be sensitive to location of that second subscriber and this can be achieved by use of the difference between the relative velocities with which the two subscribers move in space. The decision rule synthesized accordingly is based on comparison of the ratio of the likelihood functions for hypotheses  $H_1$  and  $H_2$  with some threshold. Such a decision rule is the optimum one for any specific velocity difference, an identification error of the first kind occurring when hypothesis  $H_1$  is accepted in situation  $S_2$  and an identification error of the second kind occurring when hypothesis  $H_2$  is accepted in situation  $S_1$ . The probability of each error and the threshold between the two hypotheses depend on the velocity difference, the probabilities of both errors decreasing (that of the error of the first kind after increasing to a maximum) and the threshold for acceptance of hypothesis  $H_2$  rather than hypothesis  $H_1$  increasing as the velocity difference becomes larger. The two error probabilities decrease also with increasing dimension of the control sample. Figures 3; references 3: Russian.



UDC 621.311.16:681.3.06

**Multicriterial Approach to Optimization of Power Quotas Distribution Among Users Within One Electric Power System**

18600025 Minsk IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: ENERGETIKA in  
Russian No 8, Aug 88 (manuscript received  
17 Nov 86) pp 3-7

[Article by V. I. Gordeyev, Candidate of technical sciences, docent, and S.P. Ageyev, Engineer, Novocherkassk Polytechnic Institute]

[Abstract] A multicriterial method of optimizing the distribution of power quotas among users within one system during a period of shortage is proposed, three criteria being considered rather than the usual single one (minimum total loss suffered by all enterprises owing to limitation of available power) alone. The two additional criteria are minimum reduction of total gross product and minimum reduction of the number of workers affected by limitation of available power. Solution of such an optimization problem involves four procedures: 1) determining the range of tradeoffs in the Pareto sense, 2) scalarization of the vector criterion, 3) normalization of the criteria in the case of different scales or measurement units, 4) ranking the criteria in order of importance. Scalarization here by constructing the resultant function of the partial criteria as arguments and applying the minimax technique. As an illustrative example is considered distribution of 650 MW power among eight different enterprises. Tables 1; references 5: Russian.

UDC 621.316.925.019.3:681.3

**Methods of Ensuring Reliability of Microcomputer-Based Protective Relaying Equipment**

18600025b Minsk IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: ENERGETIKA in  
Russian No 8, Aug 88 (manuscript received  
26 Jan 87) pp 16-21

[Article by L. S. Zisman, candidate of technical sciences, Ya. N. Luginskiy, candidate of technical sciences, N. N. Mitrofanov, engineer, M. V. Negevitskiy, candidate of technical sciences, and V. M. Feldman, candidate of technical sciences, All-Union Scientific Research Institute of Electrical Engineering and 'Labor's Red Banner' Belorussian Polytechnic Institute]

[Abstract] Reliability assurance for microcomputer-based protective relaying equipment on a functional rather than structural basis is considered, the three possible consequences of equipment malfunction being: failure to trigger when required to, triggering when required not to, or spurious triggering during normal operation of the power system. The function of the control apparatus are to detect transient faults and to ensure automatic recovery by restarting, to detect and

indicate chronic failures, to diagnose and to locate causes of trouble. Both hardware and software of such a control apparatus for protective relaying equipment built on a Elektronika-60 microcomputer base are described, double count being suggested as the simplest and still adequately efficient method of reliability assurance. Three variants of this method may be considered: 1) using the same program and then comparing the results, which will reveal only faults due to microcomputer calculation errors, 2) using two different algorithms for solution of the same control problem which will reveal not only transient faults but also chronic failures, 3) double count along two different operational paths, based on inherent redundancy of modern microcomputers. A basic problem of reliability assurance design is solved, for illustration, namely the necessary mean time between failures of a microcomputer for protective relaying equipment with given reliability indicators is calculated as a function of the performance index of the control apparatus over the 0.95-1.0 range of the latter. Figures 3; references 3: Russian.

UDC 621.592.3

**Prospects of Using EHD-Engines in Cryogenic Apparatus**

18600025c Minsk IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: ENERGETIKA in  
Russian No 8, Aug 88 (manuscript received  
13 Jun 86) pp 84-88

[Article by G. I. Bumagin, candidate of technical sciences, docent, Omsk Polytechnic Institute]

[Abstract] The performance of EHD compressor and expansion engine sets in cryogenic apparatus is analyzed, considering that efficient operation of such an apparatus requires a  $10^{17}$ - $10^{19}$  m<sup>-3</sup> charge carriers concentration at the entrance to the ionization space and a  $10^{-9}$ - $10^{-7}$  m<sup>2</sup>/(V.s) low charge carrier mobility in the energy conversion space. The electric strength of the active medium must be high ( $10^6$ - $10^8$  V/m) and the space charge must be neutralized. A new method of neutralization is proposed, namely feeding the high-voltage corona with voltage pulses of appropriate form and repetition rate so as to separate ionization, energy conversion, and recombination in time, preferable to use of shielding ring electrodes which separate these processes in space but allow appreciable current leakage. Two cryostats were built on this basis and tested: an 80 K cryostat with one air or nitrogen (pure nitrogen, nitrogen plus argon, nitrogen plus a hydrocarbon, nitrogen plus a Freon) compression-expansion-compression cycle and a 30 K binary cryostat with an air or nitrogen compression-expansion cycle followed by a hydrogen or neon compression cycle. Adiabatic compression from low pressure and isothermal expansion at low temperature are feasible with EHD engines, as is also an ideal Ericsson cycle. Three stages are needed for a 4 K cryostat. Figures 3; references 4: 2 Russian, 2 Western.

UDC 621.313.13.001.2

**Design of Electric Servomotors for Multifunctional Automatic Control Systems**

18600038c Moscow *ELEKTROTEKHNIKA* in Russian  
No 8, Aug 88 (manuscript received 6 Jun 87) pp 16-18

[Article by Yu. M. Belenkiy, candidate of technical sciences, G. S. Zelenkov, engineer, and A. G. Mikerov, candidate of technical sciences]

[Abstract] The design of brushless low-speed electric servomotors for heavy duty in multifunctional automatic control systems is analyzed, an important requirement being that they be constructed so as to be readily incorporated with other system components. A brushless torque motor has been developed for such an application

with all its requirements on the basis of series DBM synchronous motors suitable for operation as stepper motors and with a rectifier drive. It is designed for 27 V peak phase voltage, with the phase windings in series, parallel, or star connection. It includes a rotor position sensor and an amplifier-inverter. Its speed-torque characteristic is nearly linear. The controls have been optimized to include a voltage booster to 60 V peak per phase, continuous quick-response regulation with programming of parameters, and partial or full compensation of the amplifier-inverter time constant, the latter influencing the motor performance more significantly than the electromagnetic time constant of the stator windings. Only the stator windings generate heat, dissipation of which can be facilitated by means of a special heat absorber. Figures 1; references 5: Russian.

UDC 621.3.013.22.001.24:517.947.32

**Design of Magnetic Suspension for  
Superconducting Sphere Above Superconducting  
Torus With Confinement of Magnetic Flux**

18600024a Novocherkassk IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY:

ELEKTROMEKHANIKA in Russian No 7, Jul 88  
(manuscript received 24 Apr 88) pp 5-8

[Article by Albert Vasilyevich Kostin, senior mathematician, Scientific Research Institute of Mathematics and Cybernetics, Gorkiy State University]

[Abstract] Design of a magnetic suspension for a superconducting and thus diamagnetic sphere above a superconducting torus in a coaxial configuration is reduced to

calculation of the supercurrent density at the torus surface in such a system with confinement of the magnetic flux in the torus hole. Integration of the supercurrent density distribution over the torus surface then yields the torus supercurrent, the inductance of the torus-sphere couple, and the levitation force on the sphere. Numerical solution of the current equation with a 120-point schedule and numerical analysis of the levitation problem for spheres larger and smaller than the torus hole has yielded the dependence of the levitation force on the center-to-center distance from torus to sphere, assuming a magnetic flux of 1 Wb in the torus hole. For a niobium sphere, moreover, has been calculated the maximum attainable levitation force, also as a function of that distance and with the magnetic flux adjustable to the optimum level. Figures 4; references 7: 6 Russian, 1 Western.

UDC 539.234:543.42

**Determination of Optical Characteristics of Dielectric Thin-Film Condensates Vacuum-Deposited on Metal From Their Reflection Spectra**

18600028c Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 7, Jul 88 (manuscript received 9 Apr 87) pp 14-16

[Article by O. P. Konovalova, O. Yu. Rusakova, and I. I. Shaganov]

[Abstract] The effectiveness of infrared reflection-absorption spectroscopy in determining the optical characteristics of thin dielectric films on metal substrates is demonstrated on MgO films. The gist of this method is measuring the intensity attenuation of polarized radiation upon its reflection by a metal mirror with a dielectric coating at angles covering the 45-80 deg sector. Measurements made at wavelengths covering both lattice and impurity absorption bands yield not only the spectral characteristics of such films but also indication about their structural and physicochemical characteristics. Measurements were made for 10-300 nm thick MgO films which had been deposited by the standard electron-beam evaporation process on aluminum substrates at two different temperatures, 25 deg C and 250 deg C, the thickness of the thinner films being much smaller than the radiation wavelength and that of the thicker ones having a quarter-wavelength optical thickness for 0.003 mm radiation. Measurements were made in an RE-283 spectrophotometer with p-polarized radiation and with s-polarized radiation covering the 4000-200  $\text{cm}^{-1}$  range of wave numbers, the refractive index for 630 nm visible light having been determined ellipsometrically in a control experiment. The measurements have yielded not only the wavelengths corresponding to absorption peaks but also indication about the moisture adsorption by these films and on  $\text{Mg}_2(\text{OH})_2\text{CO}_3$  formation in them. Annealing the films at 400 deg C in air did not alter their spectra beyond attenuation of the intensity within the bands, indicating existence of strong hydrogen bonds at the surface. Figures 3; references 12: 4, 8 Western.

UDC 537.226.4:621.378.33

**Use of Ferroelectric Ceramic for Modulation of Infrared Radiation**

18600028g Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 7, Jul 88 (manuscript received 8 Jul 87) pp 40-44

[Article by M. E. Knite, M. P. Ozolinsh, and A. R. Sternberg]

[Abstract] A small high-speed high-contrast modulator for infrared laser radiation within the 0.003-0.006 mm range of wavelengths has been developed on the basis of  $\text{Pb}_{1-x}\text{La}_x(\text{Zr}_{0.65}\text{Ti}_{0.35})_{1-0.25x}\text{O}_3$  ferroelectric ceramic. The modulator is a 10 mm long bar with a 3 mm square

cross-section, made of  $\text{Pb}_{0.915}\text{La}_{0.085}(\text{Zr-Ti})$  ceramic, with Ag-paste electrodes covering one pair of opposite lateral sides, inside a metal mount between a 0.500 mm thick analyzer plate and a 0.500 mm thick polarizer plate made of  $\text{Pb}_{0.90}\text{La}_{0.10}(\text{Zr-Ti})$  ceramic each and separated from the respective modulator endfaces by a 0.050 mm wide air gap. The modulator operates on the basis of the transverse electrooptical effect. It was tested for half-wavelength voltages and voltage dependence of the transmission coefficient under static conditions, for wavelength and temperature dependence of the half-wavelength voltage, and for time characteristics of pulsed modulation. As sources of infrared radiation were used an LG-126 tunable He-Ne laser and an LGN-706 tunable CO-laser, the latter with power regulation by means of MLR-1 polarizers. A reflective diffraction grating with 150 lines/mm at a glancing angle of 24 deg was used as the cavity exit mirror. Depending on the laser radiation wavelength and on the voltage switching mode, an FD-24K photodiode, an FSG-22-3A2 photoreistor, or an ILD-2 radiation power meter was used as photodetector. For static tests, a high voltage discretely variable in up to thousand 3 V steps of  $10^{-3}$ - $10^1$  s duration was applied from a nonstandard source. For dynamic tests, high-voltage pulses of up to 2 kV amplitude and  $5 \cdot 10^{-5}$ - $10^{-1}$  s duration were applied from a nonstandard source, an S1-17 two-beam oscillograph recording the modulator response. The results of these tests indicate that the performance of such a ceramic modulator is quite comparable with that of KDP,  $\text{LiNbO}_3$ , GaAs, CdTe, ZnSe, and other single crystals. Figures 4; tables 1; references 13: 8 Russian, 5 Western.

UDC 528.835.042.6:535.214.4

**Error of Infrared Radiometers Operating With Two Standards**

18600028a Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 7, Jul 88 (manuscript received 29 Sep 87) pp 4-7

[Article by K. I. Shmelkov]

[Abstract] Analytical expressions are derived, on the basis of applicable energy and temperature relations, for the threshold sensitivity and the absolute error of infrared radiometers which operate with two standards simulating a perfect black body, as threshold sensitivity being regarded the temperature drop across a target which will generate a signal equal to the r.m.s. noise level at the output of the radiation receiver. The main source of error is fluctuation of the blackbody temperature and such factors as aging of the temperature transducers can bias the temperature estimate, the magnitude of the instrument error depending largely on the background radiation level. Figures 3; references 3: 2 Russian, 1 Western.



UDC 539.216.22.537

### Heterogeneous Thick-Film Resistors

18600033a Moscow MIKROELEKTRONIKA in  
Russian Vol 17 No 4, Jul-Aug 88 (manuscript received  
30 Jun 87) pp 291-304

[Article by I. A. Chaykovskiy, Institute of Applied Physics, MSSR Academy of Sciences]

[Abstract] The technology of thick-film cermet resistors for hybrid integrated circuits, the physical processes occurring in their structure, and their essential performance characteristics are overviewed with references to published literature, of concern being production of such composite resistors with adequate control ensuring stability of their characteristics. The technological process is broken down into five steps: fabrication of substrate and paste followed by printing with templates, drying-annealing, and trimming as the final operation. Flow of current through thick-film structure has been explained in terms of various mechanisms, four of them based respectively on the model of a two-phase medium, on barrier-tunneling, on the effective medium theory taking into account conductivity of contacts, and, at low temperatures, thermal activation of jumpwise conductivity. Considering that the effective conductivity of the a cermet material depends on the volume fraction of metal, the effective conductivity has been shown to approach zero as the metal content is decreased to a certain critical threshold volume fraction. The conductivity of thick-film resistors in a magnetic field is an important consideration, the effective medium theory having been a useful tool for calculating the Hall coefficient as well as the temperature coefficient of resistance. Two important factors influencing the performance characteristics of thick-film resistors are their sensitivity to mechanical strain, the elasto-resistive effect, and 1/f-noise generated by conductivity fluctuations. The authors thank M. G. Abrazov and N. I. Rechster suggesting the topic, Ye. A. Popov, V. N. Chebotar, A. I. German, and I. A. Vasilyev for assistance. Figures 6; references 63: 17 Russian, 46 Western (3 in Russian translation).

UDC 537.32

### Selection of Cooling Temperature for Shield Around Thermoelectric Cell

18600037d Leningrad IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY:  
PRIBOROSTROYENIYE in Russian  
Vol 31 No 8, Aug 88 (manuscript received  
9 Nov 87) pp 93-95

[Article by V. P. Babin, Ye. K. Jordanishvili, A. A. Kodirov, M. B. Nabiyeu, and Kh. O. Olimov, Leningrad]

[Abstract] Insulation of a Peltier-type thermoelectric cooling cell for operation in vacuum below room temperature is considered, plain shielding even with a low-emissivity material being inadequate. A simple scheme

is proposed, namely surrounding the cell with a shield at a uniform temperature to simulate adiabatic insulation rather than with an array of identical cells all at the same temperature as the given one. The problem of designing such a shield is selecting the temperature to which it should be cooled by the cell it surrounds. This problem is solved analytically by assuming, in the first approximation, a constant radiative heat transfer coefficient and by linearizing on this basis the corresponding differential equation of heat conduction with boundary conditions of heat balance at the shield surface and constant temperature at the cell surface. At the optimum electric current density, which depends on the radiative heat transfer coefficient, the necessary effective shield temperature is found not to depend on that coefficient but to be equal to the average of two ultimate temperatures: that of the heat emitting junction and that of the heat absorbing junction. References 4: Russian.

UDC 621.391.029

### Effect of Third-Order Dispersion on Dynamics of N-Soliton Pulses in Optical Fibers

18600032d Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 6, Jun 88 (manuscript received  
15 Dec 86) pp 756-760

[Article by V. A. Vyslouch and N. A. Sukhotskova, Moscow State University]

[Abstract] Interaction of two solitons in an optical fiber and subsequent evolution of their coupled state, also of that of three solitons, are analyzed with third-order dispersion taken into account. The corresponding equation, a complete partial differential equation of third order with respect to time and of first order with respect to distance for the complex amplitude of the envelope which covers the electric field of a light wave, was solved by numerical integration for initial conditions of a purely real sech-function envelope amplitude and a power 4.9 times higher than critical. On the basis of the solution and by the method of moments are evaluated, in terms relative to the effects of second-order dispersion, the effects of third-order dispersion on the collision length for two cophasal solitons initially separated by a given time interval, on the compression of N(2,3)-soliton pulses, and on the possibility of their coupled state decaying within the first soliton period as well as on the dynamics of such a decay. The results indicate that the motion of the center of a pulse array is quite accurately describable by the equation of a straight line for the energy of such an array. They also confirm another known effect of sufficiently strong third-order dispersion, namely weakening of soliton-soliton interaction when the initial separation of solitons is large and thus a possibility of data transmission over long distances. Figures 3; references 10: 1 Russian, 9 Western.



UDC 537.876:621.372.8

**Nonlinear Conversion of Continuous Doubly  
Frequency-Modulated Signal in Optical Fiber**

18600032e Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 6, Jun 88 (manuscript received  
16 Jan 87, after revision 24 Aug 87) pp 760-763

[Article by N. N. Akhmediyev, L. L. Betina and V. I.  
Korneyev]

[Abstract] Propagation of signals through optical fibers with negligible attenuation and higher-orders dispersion is considered, this process being adequately described by the nonlinear Schroedinger equation. This equation, with an arbitrary whole number as parameter, was solved by the numerical method of expansion coefficients for the form of propagating pulse signals and for the spectrum of propagating continuous-wave signals, particularly one frequency-modulated by two harmonics. Two different procedures were used for calculating the expansion coefficients and the results were compared. The spectra of such signals are then compared with those of harmonically simply frequency-modulated continuous signals in an optical fiber. Figures 2; references 9: 2 Russian, 7 Western (1 in Russian translation).

UDC 621.396.624

**Feasibility of Acoustooptical Fourier Analysis of  
Optical Signals**

18600040g Moscow RADIOTEKHNIKA i  
ELEKTRONIKA in Russian Vol 33 No 7, Jul 88  
(manuscript received 12 Nov 86) pp 1515-1518

[Article by V. V. Proklov and S. V. Sokolovskiy]

[Abstract] Spectral analysis of optical signals or their envelopes by way of Fourier transformation with the aid of two identical acoustooptic space modulators in phase quadrature is proposed, the feasibility of this method being demonstrated on light which has undergone intensity modulation during passage through an optical fiber. This light is split into two beams for two identical analyzer channels. Each light beam encounters in its acoustooptic modulator  $N$  acoustic traveling waves of same intensity but different frequencies, these acoustic waves having been generated in each modulator by an array of high-frequency oscillators and amplitude-modulated by a common array of low-frequency oscillators. The output signal from each acoustooptic modulator passes through a lens to a linear array of photodetectors. The electric output signals from the two photodetector arrays are fed to a summing device, after each has passed through its low-pass filter, integrator, and squarer. An experimental prototype of such an acoustooptic analyzer with both modulators made of  $\text{TeO}_2$  ceramic was found to have a relative frequency resolution equal to 3-4 pct of the low frequencies and a dynamic range of about 40 dB in terms of the input signal level. A sampling period much shorter than the reciprocal of the sample frequency allows interspersing of samples and thus simultaneous processing of signals from several channels with one acoustooptic cell. Figures 3; references 4: 1 Russian, 3 Western.

**Anomalous Radio Wave Attenuation in a Disturbed Ionosphere**

18600090b Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 10, Oct 88 pp 1164-1168

[Article by V. L. Frolov]

[Abstract] This study employs results from recent investigations of small-scale ionospheric inhomogeneity generation and relaxation characteristics to examine the dynamics of their spectrum and to analyze the features of pump wave interaction with plasma which explains a number of observed phenomena in the development of the anomalous attenuation effect. All the experiments in this article apply primarily to measurements at frequencies between 4.6 and 6.8 MHz at radiation powers of 20 MW where the most extensive experimental material is available. There are several developmental stages of small-scale inhomogeneities in the perturbed region of the ionosphere and a certain "delay" exists when these diagnostic techniques will not be successful in identifying the development of artificial ionospheric inhomogeneities. However the observed dynamics of the spectrum occurring in the development and relaxation of artificial ionospheric inhomogeneities makes it possible to explain certain experimentally-observed features of pump wave interaction with F-layer plasma. The temporal and energy characteristics of the observed modulation transfer effect can be attributed to test wave scattering by the artificial ionospheric inhomogeneities three meters in length. It is significant that in this range the most intense development of artificial ionospheric inhomogeneities initially occurs after activation of the pump waves; this development is particularly strong at high power levels. As the entire spectrum of the inhomogeneities develops the decameter inhomogeneities become increasingly important in determining the anomalous attenuation coefficient and the modulation percentage drops substantially. The dynamics behind the artificial ionospheric inhomogeneity spectrum are used to explain the observed features of the development of the anomalous attenuation of O-polarized radio waves as well as to provide an interpretation of the pump wave modulation-to test wave transfer effect.

**Geomagnetic Field-Induced Wave Processes in the Ionosphere**

18600090c Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 10, Oct 88 pp 1169-1179

[Article by V. M. Sorokin]

[Abstract] This article considers geomagnetic field-induced wave processes occurring in the ionosphere as well as attendant perturbations. This process is based on an analysis of Maxwell's equations as well as quasi-hydrodynamic equations of a weakly-ionized plasma in a magnetic field in a range of periods from tens of seconds to tens of minutes in order to substantiate the possible

physical mechanisms behind the formation of magnetoionospheric wave perturbations. Low-frequency electromagnetic waves in ionospheric plasma is analyzed and it is demonstrated that the influence of molecules on their distribution in the lower ionosphere produces waves whose phase velocity is comparable in magnitude to the velocity of the magnetoionospheric wave perturbations. The theory of these waves is then used as the basis to interpret the properties of the perturbations under consideration. Since wave properties differ substantially in homogeneous and inhomogeneous media the dispersion characteristics of low-frequency electromagnetic waves whose lengths significantly exceed the layer width in which they are propagating are considered. An approximate method is then used to derive general relations that relate the geomagnetic field oscillations and the ionospheric perturbations coexisting with magnetoionospheric wave perturbations. Extensive direct observations have demonstrated a correlation between geomagnetic field oscillations at medium latitudes and frequency or phase fluctuations of a radio wave reflected by the F-layer. The experimental and theoretical analysis reveals that magnetoionospheric wave perturbations are generated both by hydrodynamic and electromagnetic action on the ionosphere and that such perturbations propagate at velocities of tens of kilometers per second in periods ranging from tens of seconds to tens of minutes. The analysis of low-frequency electromagnetic waves revealed that analogous properties are found in waves located in the lower ionosphere, revealing the possibility of applying the theory of these waves to an interpretation of the properties of magnetoionospheric wave perturbations.

**Amplification of RF Electromagnetic Signals in Semiconductor Layers with a Dimensionally-Quantized Electron Spectrum**

18600090e Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 10, Oct 88 pp 1253-1260

[Article by L. K. Orlov]

[Abstract] This article examines the absorption spectrum and amplification of RF radiation by a three-layer semiconductor structure having two quantum wells and separated by a tunnel-transparent potential barrier and located in a strong electromagnetic wave field. The nature of resonance peak splitting in the spectral curves is analyzed in strong fields in conditions of multiphoton resonance. The analysis of the nonlinear RF properties of the semiconductor structures accounts for electron transitions only between the two lower two-dimensional subbands of the conduction band. A two-level model can be used to investigate the response of the system to strong external fields by using an inhomogeneous semiconductor layer with a specific potential relief as an example. The resulting spectral dependences of the RF conductivity are resonant in nature, while their form is substantially dependent on the amplitude and frequency of the pump field. Even with very weak pump fields the

resonant features in the absorption spectra of a weak signal begin to experience strong splitting whose magnitude increases with increasing field amplitude. At exact resonance the spectral dependences are symmetrical and an asymmetry to one or the other side will occur with loss of resonance. The splitting of the resonance absorption peaks is caused by the elimination of degeneration or the activation of intersubband electron transitions between the resonant states of different "quasi-energy ladders." The amplification can be attributed to induced radiation in a nonequilibrium medium created by the strong RF pump field, although it occurs in the absence of a population inversion in the two-dimensional subbands in the film. The numerical analysis results are in complete agreement with previous results from approximate models as well as experimental results.

**Influence of Electrodynamical Effects on the Rayleigh-Taylor Instability of the Equatorial Ionosphere**

18600090f Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 10, Oct 88 pp 1261-1263

[Article by A. V. Pets and S. V. Sazonov]

[Abstract] Large-scale traveling inhomogeneities ("bubbles") observed in the equatorial ionosphere are related to Rayleigh-Taylor instability, and the present study is devoted to calculations of the linear increment of the Rayleigh-Taylor instability. Quasi-hydrodynamic plasma equations are used to find the ion and electron velocities and, as is normally the case, the viscosity and inertial terms are ignored in the calculation. It is assumed that the plasma temperature is fixed and there is no external electrical field or neutral wind. The analysis is carried out for F-layer altitudes. A dispersion relation is derived for the linear increment of the Rayleigh-Taylor instability, and the solutions of this dispersion equation become complex if  $x$  is less than  $x_p$ . The case where the appearance of an instability is characterized by the existence of an imaginary component in  $\gamma$  is given special attention. Such Rayleigh-Taylor instability development conditions are called oscillatory conditions. It is demonstrated that at the point where oscillation damping due to plasma recombination and diffusion is compensated by the Rayleigh-Taylor instability, the frequency and group velocities along and transverse to  $H$  are determined by specific relations that suggest that growth of the recombination frequency and increasing electron plasma frequency have a favorable influence on the development of the vibrational Rayleigh-Taylor instability conditions. A periodic variation in the intensity of luminescence lines at 6300 angstroms and 7774 angstroms was observed for electron "bubbles". This luminescence is normally related to oxygen recombination processes.

**Waveguiding Properties of Randomly Stratified Media**

18600090d Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 10, Oct 88 pp 1210-1217

[Article by S. A. Gredeskul and V. D. Freylikher]

[Abstract] The spatial distribution of energy field fluxes from a point source in a randomly stratified layer is investigated and it is determined how such a randomly-stratified generally homogeneous medium influences propagation range, specifically whether or not the medium has waveguiding properties. It is determined that the dependence of the field energy flux of the point source in the randomly-stratified medium is the same as in a regular waveguide dielectric layer. However, the flux distribution with altitude in a random layer and the dependence of the waveguiding factor on the layer thickness have a number of specific properties and existing concepts on the spectral structure and states in uniform disordered systems are employed to identify these features. It is demonstrated that in spite of the lack of regular refraction with a sufficient layer thickness a portion of radiated energy will be channeled along the layer in virtually every realization. This qualitative structure of discrete and continuous waves occurs for a randomly spatially-homogeneous function with diminishing correlations. This structure serves as the basis for an analysis of the field flux expressions. It is determined that the differences in the behavior of the field fluxes are due to fluctuations of exponentially low probability and indicate that fluxes averaged over the realizations do not yield information.

**RF Signal Structure in Oblique Earth-Backscatter Ionospheric Sounding Signal**

18600100a Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 8, Sep 88 pp 1027-1035

[Article by M. V. Tinin and S. M. Mikheev]

[Abstract] This study employs an interferential integral method to obtain formulae to describe oblique ionospheric sounding and to construct a method of calculating the structure of an oblique earth-backscatter RF signal that takes into account both the random ionospheric irregularities and caustic focusing in the vicinity of the skip zone boundary. Calculation results suggest that the ionospheric irregularities serve to broaden the RF pulse and to reduce its amplitude. A comparison to normal geometric optical calculations reveals that geometric optics cannot provide an estimate of the oblique earth backscatter signal amplitude and it is necessary to take into account the random ionospheric inhomogeneities in order to improve signal wavefront calculation accuracy. The diagrams also indicate that taking into account the directional pattern will serve to both shift the signal maximum and will also produce several maxima. A comparison to calculations provided in previous



studies shows that the random atmospheric irregularities serve to flatten out the signal envelope. The method of calculating the signal structure proposed in this study makes it possible to take full account of the signal focusing effects in the vicinity of the skip zone boundary. It is these effects and the random ionospheric inhomogeneities that are largely responsible for the behavior of the signal leading edge as well as the main maximum that are the primary measured parameters in ionospheric diagnostics by means of oblique earth backscatter techniques. This method can therefore be useful to evaluate the influence of random ionospheric inhomogeneities on the accuracy of determination of both the trajectory and energy characteristics of an RF signal by means of oblique earth backscattering.

**Three-Dimensional Diffraction Problem for an Ideally-Conducting Wedge With Edge-Mounted RF-Absorbing Cylinder**

18600100b Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 8, Sep 88 pp 1074-1081

[Article by O. I. Sukharevskiy and A. F. Dobrodnyak]

[Abstract] This article is devoted to solving a diffraction problem for an oblique-incidence plane electromagnetic wave on an ideally-conducting wedge whose edge is covered by a circular cylinder fabricated from an absorbing material. Formulae are also derived that make it possible to estimate the nongeometric-optical part of the far field scattered by the wedge taking into account diffraction effects caused by the absorbing cylinder. In the case of oblique irradiation of a wedge structure with a cylindrical inhomogeneity, the field radiated by the edge covered by an absorbing cylinder takes the form of conical waves diverging away from the end of the wedge and allowing effective calculation by the derived formulae. The method developed in the article is used to carry out calculations of functions for the region located near the end of the wedge and for the far field. A number of calculations were carried out in order to establish the dependence of the scattered field level on the following parameters: the apex angle of the wedge, the radius of the absorbing cylinder and the electrical characteristics of its material, the angle of inclination of the wave vector and the position of the polarization vector of the incident wave with respect to the end of the wedge. The calculations employing this method were also used to estimate the perturbing influence of the edge of the wedge on the diffracted field level along the wedge ends and the dependence of this perturbation on the radius of the absorbing cylinder. Calculations revealed that at distances from the end of the wedge of the order of one to 1.5 times the wavelength the field strength values remain virtually identical to corresponding values calculated in a physical optics approximation. The absorbing cylinder somewhat reduces the field level near the cylinder. However, even at distances of 1 to 1.5 of the wavelength from the cylinder edge its influence becomes negligible. The method developed in this study allows computer

calculation of the complete diffraction fields near the end of the wedge and also can be used to estimate the non-geometric optic portion of the far field scattered by an ideally-conducting wedge taking into account the diffraction effects caused by the absorbing cylinder.

**Plane Electromagnetic Wave Diffraction by Dielectrically-Coated Cylinder of Finite Length**

18600100c Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 8, Sep 88 pp 1082-1090

[Article by E. N. Vasilev and Z. V. Sedelnikova]

[Abstract] Integral equations are used to analyze plane electromagnetic wave diffraction by bodies of revolution of random shape coated by a dielectric or plasma. A rotation coordinate system is introduced for calculation purposes with the surfaces  $u = \text{const}$  coinciding with the interfaces. The fields, currents, and Green's function in the integral equation system are all expanded into a Fourier series in the azimuthal coordinate  $\psi$ . The orthogonality of the trigonometric functions allows writing the system of integral equations for the azimuthal harmonics of the current densities. The system contains only one-dimensional integrals which substantially improves the effectiveness of the numerical solution. The equivalent current densities are used to calculate the scattering patterns by means of existing formulae. The calculation results for the scattering characteristics are given for isolated azimuthal harmonics. All scattering patterns are normalized to unity. The normalization coefficients determining the contribution of each separate harmonic are provided. For axial wave incidence the scattering characteristic is similar to that of traveling-wave antennas which naturally derives from the analysis of the equivalent current distribution. Initially the  $E_\phi$  component is the only component to have an image lobe with increasing angle of incidence. The axial lobe attributable to the surface wave currents is observed. A further increase in the angle of incidence will cause the image lobe to become stable. The magnitude of the axial lobe fluctuates in the direction of wave propagation. The same can be said regarding the trailing axial lobe.

**Determination of Internal Temperature Profile by Multifrequency Radio Thermography for Medical Applications**

18600100d Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 8, Sep 88 pp 1104-1112

[Article by K. P. Gaykovich and M. I. Sumin]

[Abstract] This study considers theoretical and experimental aspects of a method for determining the temperature stratification of human tissues based on multifrequency measurements of human thermal radio emission.



The results obtained in this study are based on extended research. Calculations of the dielectric parameters of various tissues were based on previous research data. These studies have developed and successfully applied a method of recovering the temperature profile based on a solution of ill posed inverse problems formulated by the Tikhonov Soviet school of mathematics. The analysis begins with a consideration of thermal radio emission from a half-space containing a multilayered structure. Solving the electrodynamic problem for such a structure makes it possible to calculate the thermal radio emission intensity through the coherence function of the electrical field at the boundary as well as its brightness temperature. The derived equation is an ill-posed problem in the sense of study [7]. It is necessary to incorporate a priori information on the desired exact solution in order to solve this problem. The Tikhonov regularization method was employed. The effectiveness of any specific algorithm for solving an ill-posed problem can be established only by numerical experiment. The method proposed here was used to develop solution algorithms and to conduct numerical experiments that made it possible to establish an information wavelength range as well as the requirements on the measurement level accuracy and the necessary number of frequency channels for various distributions varying in their degree of complexity, characteristic width, and temperature differential. The number experiment revealed that the primary types of profiles are recovered with a high degree of accuracy with measurement accuracies of 0.01-0.03 deg Kelvin and approximately 10 measurement channels within the wavelength ranges of interest (the centimeter and decimeter wavelength ranges). The measurement wavelengths must be selected so that the thickness of the skin layer increases uniformly from a few millimeters to maximum values, since the probe depth is determined by the skin layer thickness of the probed tissues which is primarily dependent on the water concentration in the tissues. Also given are results from the recovery of the internal temperature distribution based on radiometric data in tumor conditions. The inverse problem solution algorithm used the natural constraint  $T(z)$  is greater than or equal to  $T(0)$  and it was assumed that the dielectric parameters of the tumor were identical to the corresponding parameters of the surrounding tissue. The results from the experimental investigation demonstrated the possibility for diagnostic investigation and monitoring of tumor and inflammation processes causing local changes in temperature. Another important application of radiometric probing is monitoring the degree of tissue heating occurring in microwave hyperthermia therapy for tumors. Overall these results reveal the actual promise and limitations of radiometric probing to recover the inner temperature profile of the human body based on multifrequency measurements of thermal radio emission and they establish a methodological and algorithmic basis for solving other probe problems for other media with a multilayered dielectric structure.

**Influence of Diffraction Effects on Intensity Fluctuation Dispersion for Wave Beams Propagating in a Turbulent Medium**

18600100e Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 8, Sep 88 pp 1136-1138

[Article by G. M. Samelson]

[Abstract] The relative dispersion of intensity fluctuations of wave beams propagating in a turbulent medium is a function of the distance of the observation point from the beam axis as well as the diffraction parameters, particularly the Fresnel number of the radiating aperture. A number of studies have investigated the relationship between the dispersion and the Fresnel number. Theoretical investigations carried out for strong field fluctuations in both the phase space by the Huyghens-Kirchhoff method and by means of an asymptotic solution of the equation for the fourth field moment are not in agreement with experimental data. The present study demonstrates that the Huyghens-Kirchhoff method can be used to obtain a better agreement between experimental results if diffraction effects are taken into account in calculations of phase fluctuations of elementary spherical waves. Unlike the geometric optics approximation used previously, the principal expression in this study takes into account the diffraction effects existing in the far field. Other approximations make it possible to carry out a numerical calculation to produce values of  $\beta(r)$  for different beam diffraction and turbulence levels along the propagation route. The analysis demonstrates that taking into account diffraction effects in the strong fluctuation range will serve to increase the calculated values of the relative dispersion in narrow beams and will therefore produce a better agreement with experimental data.

**Investigation of an Active Adaptive System for Two-Mode Acoustic Field Damping in a Closed Air Volume**

18600100f Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 8, Sep 88 pp 1141-1143

[Article by I. A. Korolev and A. A. Maltsev]

[Abstract] This study presents results from an experimental investigation of a complex adaptive system for two-mode acoustic field damping in a closed air volume. The study considers damping of a single low-frequency mode with a simple spatial structure and a single high-frequency mode with a "complex" spatial structure. The measurement results for an acoustic field along the axis of the damping region for an initial field without damping and a residual field with an activated damping system show that in active damping of high-frequency modes with a complex spatial structure the effectiveness of the adaptive active damping system is diminished somewhat while the degree of compensation is heavily dependent on the measurement point. Another subject

of investigation is the simultaneous damping of two modes of different frequencies and spatial structures. Measurement results of the effective sonic pressure along the axis of the damping region for both the initial sum field without damping and the residual field when the damping system is activated revealed that the active damping system operates in this case with virtually the same efficiency as in mode damping at one frequency and the degree of sum field compensation averaged minus 17 dB. A comparison of the results shows that by increasing the number of degrees of freedom in the adaptive active damping system it was possible to achieve nearly independent simultaneous compensation of two modes with different frequencies.

UDC 621.318:681.327.6

**Sawtooth-Shaped Domain Wall In Metal Films for Digital Magnetic Recording**

18600033a Moscow MIKROELEKTRONIKA in Russian Vol 17 No 4, Jul-Aug 88 (manuscript received 20 Feb 87) pp 321-326

[Article by V. S. Semenov and A. A. Faktorovich, Institute of Control Problems]

[Abstract] The domain recorded on a metal film by a square current pulse passing through the coil would on a magnetic head is described in terms of a sawtooth-shaped domain wall forming in the process. The energy of such a domain in an external magnetic field is calculated by integrating the product of longitudinal magnetic field component expressed in the Karlquist approximation. To this is added the domain wall energy, which comprises not only the energy of neutral wall segment but also the energy of anisotropy and the magnetostatic energy of fields scattered by unipolar charges on the domain wall. On the basis of the total domain energy are determined the relevant domain parameters, namely the changes in its dimensions owing the magnetization reversal during recording with the magnetic field turned on and during storage with the magnetic field turned off. Some of the change in dimensions upon removal of the magnetic field is due to demagnetization, which may or may not occur depending on the configuration. For numerical design analysis of "magnetic head—magnetic disk" pairs, the parameters of a reverse-magnetization domain were calculated on a computer assuming various combinations of head and disk characteristics. Figures 4; tables 1; references 11: 4 Russian, 7 Western.

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**Low-Temperature Diffusion of Phosphorus**

18600033c Moscow MIKROELEKTRONIKA in Russian Vol 17 No 4, Jul-Aug 88 (manuscript received 17 Mar 87) pp 371-373

[Article by A. E. Naumov and N. K. Shubina]

[Abstract] An experimental study was made concerning diffusion of phosphorus into "shallow"  $n^{+}$ -regions during oxidation and doping of silicon in water vapor at

temperatures below 900 °C. Wafers of KDB-10 Si with (111) orientation were, after chemical treatment, doped with P from a liquid  $PCl_3$  source. This was done in two stages: first at 900-1000 °C over a period of 15 min and then, after removal of the phosphorus-silicate glass with HF, at 850-900 °C over periods of 10-40 min. The results reveal that simultaneous diffusion and oxidation at 850-900 °C cause the surface resistance of the diffusion layer to increase, rather than to decrease as it does at temperatures above 900 °C. A subsequent analysis of the dynamics of phosphorus distribution in the diffusion layer, based on measurement and integration of the P distribution profile, has revealed that the total P content in the diffusion layer decreases in the process. Numerical estimates have been made in the approximation of a stepped-profile P distribution in the oxide layer. They indicate that the P content in this layer decreased when the oxidation time is lengthened and that the resulting P concentration gradient causes phosphorus to migrate toward the Si-SiO<sub>2</sub> interface. In the oxide layer phosphorus exists most likely in an hydride form, while at the Si-SiO<sub>2</sub> interface it exists in elementary form after the  $2P_2O_5$  plus 5Si yielding 5SiO<sub>2</sub> plus 4P reaction has taken place. Figures 1; references 5: 1 Russian, 4 Western.

**Possibility of Wind Drift Compensation by Oblique Radioacoustic Atmospheric Sounding**

18600090a Gorkiy IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 10, Oct 88 pp 1160-1163

[Article by A. L. Fabrikant]

[Abstract] This study proposes a method of compensating wind drift based on the use of oblique radioacoustic atmospheric sounding and elevational and azimuthal searching. If the wind speed increases with altitude in oblique sounding there will be a simultaneous drift of the wave pulse in the wind direction and an inversion of the acoustic phase velocity due to the wind shear. This study determines the conditions in which these two effects will cancel. In order to use such compensation in radioacoustic atmospheric sounding it is necessary to carry out sounding at various angles. Existing studies on oblique radioacoustic atmospheric sounding are limited to investigations of the possibilities for sounding at fixed angles. When carrying out atmospheric sounding using the method developed in this article it is possible to determine the vertical profiles of altitude-averaged wind temperature and speed. Wind drift compensation by means of oblique sounding at optimum angles can increase radioacoustic atmospheric sounding range and reduce the dependence of this remote sensing method on weather conditions.

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